Developing an Instrument to Study the Impact of Functional Load on the Perception of Spoken English by L2 Learners

A PLAN B PROJECT
SUBMITTED TO THE FACULTY OF THE GRADUATE SCHOOL
OF THE UNIVERSITY OF MINNESOTA
BY

KAREN MARIE GOSSELIN

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
MASTER OF ARTS IN SECOND LANGUAGE STUDIES

JANUARY 2011

Ready for Defense as a Plan B Project:

Project Supervisor | Date

Abstract

A common challenge ESL instructors are faced with today is the prospect of having to teach to students of multiple language backgrounds. There is a need to establish some principles in looking at L2 speech perception in order to guide teachers in their curricular selections. One approach for pronunciation instructors looking to help their L2 learners to become effective communicators is to concentrate first on those aspects of L2 phonology that most affect intelligibility and comprehensibility. Functional Load theory is something instructors can easily use in the classroom for identifying learners' intelligibility issues with segmental features. The testing of perception of segmental features is a useful way to offer focus and development for pronunciation instruction. Because not every instructor has time to dedicate to developing assessments of segmental speech perception, herein is proposed an instrument that can be used by instructors to study and identify some key issues in speech perception as they relate to high and low functional load (FL) errors. The principle of Functional Load has become useful for choosing what segments should be included in speech perception analysis and training.

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Introduction

Pronunciation and speech perception play an important role in learners' acquisition of a new language. In many language learning environments, there is limited time to address every aspect of learners' phonological difficulties as instruction time must be allocated sufficiently, and skills such as reading, writing and listening seem to take priority. However, even in classes dedicated to oral skills, with a wide range of curriculum options now available, there is still not a clear consensus regarding best practices.[i] In such an environment, a range of approaches to teaching and assessing second language phonology may be useful. This paper explores one such approach, a way to assess learners' perception of segmentals in English as a second language.

In the development of phonological features in second language acquisition, segmentals, as small as they are, play an important role in pronunciation and accentedness. Data suggests (Koster & Koet, 1993; Munro & Derwing, 1995a, 1995b) that segmental errors (errors in individual sounds) have a more detrimental effect on comprehension than suprasegmental errors (rhythm and intonation), although the most serious breakdowns involve both types of errors. The difficulty L2 listeners encounter with segmental contrasts, especially those who have had little exposure to spoken English, has most often been explained by the notion that learners possess a language-specific "phonological filter" through which non-native phones must pass (Hallé, Best, & Levitt, 1999). A classic example of perceptual constraints imposed by the native system of phonological contrasts comes from investigation of the English /r/-/l/ contrast as heard by English L2 learners whose language lacks a rhotic /r/ vs. lateral /l/ phonological contrast (for example, French or

Japanese learners). According to this logic, speakers of languages who do not possess an /r/-/l/ distinction should encounter perceptual difficulty with the English /r/-/l/.

The design of an ESL pronunciation syllabus would be more effective if individual student needs were identified through analysis of learner variables and a collection and diagnosis of their speech perception and speech samples. There are several reasons why ESL teachers, as well as learners of English, should include diagnosis of speech perception. First, both Flege (1995) and Escudero (2005) maintain that many production errors have a perceptual basis and that speech perception plays an important part in the acquisition of pronunciation. These claims are supported by several studies that indicate that perception precedes production (Aoyama, Flege, Guion, Akahane-Yamada, & Yamada, 2004; Flege, Schirru, & MacKay, 2003; Rauber, Escudero, Bion, & Baptista, 2005) and L2 learners cannot produce sounds accurately without first perceiving differences between them and similar L2 or L1 sounds (Derwing & Munro, 1997; Flege, 1995; Underbakke, 1993). Second, perceptual training is often used to improve both L2 perception and production (Cenoz & Lecumberri, 1999; Flege, 1995; Underbakke, 1993; Wang, Jongman, & Sereno, 2003). Teaching learners to identify and discriminate L2 sounds correctly plays an important role in self-monitoring (Acton, 1984; Morley, 1991). Students can play an essential role in their perceptual training as they work with teachers to prioritize their goals. Finally, perception is easier to assess in learners than is production. There is an obvious advantage in practicality – administrative time, speed in scoring and efficient reporting of results. Production tests require individual administration, in addition to an analysis of the oral production, which can be very subjective. Instructors' "perception" of a learner's production may not be mutually shared as each may have very different prior experiences with ESL learners (Larsen-Freeman, 1978). Speech perception, perceptual training and self-monitoring have all been regarded as important in successful language learning experiences.

The testing of perception of segmental features is a useful way to offer focus and development for pronunciation instruction. Because not every teacher has time to dedicate to developing assessments of segmental speech perception, I propose below an instrument that can be used by teachers to identify some key issues in speech perception as they relate to high and low functional load (FL) errors.

Literature Review

Speech Perception

Many phonetic and phonological mistakes in production can be attributed to first language influences. Sound system differences between the native language and the target language pose various degrees of difficulty to learners which, at a perceptual level, will be manifested as confusions. For example, one item that differentiates languages is the number of vowel phonemes. When a native language has one phoneme and the target language has two, it is likely that learners will confuse the two target language units favoring the one closest to their native category. Two of the most influential models that try to explain nonnative sound perception are Best's Perceptual Assimilation Model (PAM) (Best, 1995; Best, McRoberts, & Goodell, 2001) and Flege's Speech Learning Model (SLM) (Flege, 1995; Flege, Schirru, & MacKay, 2003). Both models predict that 1) the more distant an L2 sound (phonetic segment) is from the closest L1 speech sound, the more learnable the L2 sound will be and 2) if two L2 phonemes are perceived as only one L1 phoneme (i.e., both L2 variants are equally good examples of the L1 phoneme) then nonnative discrimination will be poor. Flege's model incorporates mechanisms similar to those described in Best's, but assumes that they are mostly effective in initial stages of second language acquisition. According to Flege the greater the perceived phonetic dissimilarity between L2 and L1 sounds, the more likely learners will be to discern the difference and show measurable progress in perception and/or production over time.

Along the same line, research also suggests a relationship between L2 sound perception and production (Aoyama et al., 2004; Bion, Escudero, Rauber & Baptista, 2006;

Kluge et al., 2007). For example, L2 vowel sounds that are poorly discriminated in perception are often produced in a manner that is similar to that of a single vowel in the learners' L1 (Rauber et al., 2005). The same has proven to hold true for consonant sounds (Aoyama et al., 2004). This hypothesis was evaluated in various studies which will be reviewed here.

Japanese speakers' difficulty in discriminating English /l/ and /r/ is often attributed to the perceptual assimilation of English [l] and [⟧] by a single Japanese [∡] (at least in syllable-initial position). Based on the findings of previous studies which suggest that the English [⟧] is phonetically more dissimilar from the Japanese [∡] than the English [l] is, according to Aoyama et al. (2004) the Speech Learning Model would predict that Japanese speakers would show greater learning for [⟧] than [l]. In order to test this theory, Aoyama et al. designed two experiments which examined the perception and production of English consonants by 16 native Japanese adults and 16 native Japanese children. By the end of the study, the participants had been in the United States for less than two years. Each test (perception and production) was administered to the same group of participants two times (T1 and T2), with approximately 1 year intervals, in order to determine improvement over time between children and adults.

A categorical discrimination test (CDT) was employed to examine the contrasts /l/-/r/, /r/-/w/, /b/-/s/, /s/-/□/ and /b/-/v/. The /b/-/s/ contrast was included as a control, while the other contrasts were chosen as they are considered difficult for Japanese L2 speakers of English. However, the two contrasts which included /l/ and /r/ (i.e., /l/-/r/ and /r/-/w/ contrasts) were of primary interest. Participants listened to recordings of a NAE speaker producing triadic tokens of [l≙, ⟧≙, w≙, b≙, s≙, □≙, v≙] and were asked to identify the position (“1”, “2” or “3”) of the odd item out or indicate “no” if they did not hear an odd item out.

The purpose of the production experiment was to examine the learners’ production of English [l], [ɹ] and [w] in English words beginning with these sounds. Participants were shown 26 pictures separately on a computer screen while hearing the corresponding word. They were also given the equivalent word in Japanese to reduce uncertainty of what was said. The pictures were randomized and presented three times each and the participants were recorded saying the test word three times. Only their first and third productions were used in the experiment. Digitized recordings of the participants’ production of *light*, *leaf*, *write*, *read*, *watch* and *wing* were prepared for evaluation. The final consonants were deleted, leaving the initial consonants and the following vowel (in the case of the diphthong in *light* and *write*, the second element of the diphthong /a⋂/ was removed as well). This was done so that the judgments of the initial consonants were less likely to be affected by lexical identity. The test words were examined by twelve native speakers of English who were asked to identity the initial consonants in the CV stimuli.

In the perception tests, the amount of improvement observed in the Japanese participants depended on the contrast and age. Their results showed that while the Japanese children’s discrimination scores for /l/-/r/ and /r/-/w/ were lower at the time of the first test, the children’s scores improved significantly from T1 to T2 while the adults’ scores did not, although the Japanese adults had an initial advantage over the Japanese children in discriminating /l/-/r/ and /r/-/w/. Aoyama et al. (2004) concluded that this was most likely due to the fact that the adults had studied English in school before arriving to the US, where the children had not. However, in the course of one year, the children’s performance improved while the adults' leveled off. The results also showed that there was a greater learning for the perception of [ɹ] than of [l] by the Japanese learners of English, as Aoyama et al. had predicted.

Aoyama et al. also found that the Japanese children's production of English consonants improved over time; specifically more improvement was shown for [ɹ] than for [l], while the Japanese adults' production showed little change from T1 to T2 for all three consonants. In addition, while the participants' [w]s were more often identified as intended, their [l]s were misidentified as [ɹ] and their [ɹ]s were misidentified as /l/ at T1. The authors computed 'relative improvement' scores for each group of learners. For the Japanese children, the relative improvement was 49.3% for [ɹ] and 18.5% for [l], while it was significantly lower for adults (16.0% for [ɹ] and 11.7% for [l]). Aoyama et al. concluded that more learning took place for English [ɹ] than for [l] as was predicted by the Speech Learning Model.

Taking into account vowel inventory size difference together with the Perceptual Assimilation Model's claim that two non-native sounds can be assimilated into a single category, Rauber et al. (2005) investigated the relationship between perception and production of English L2 vowels. Rauber et al. designed two experiments: one in which Brazilian Portuguese learners' production of English vowels was recorded, analyzed and compared with that of English speakers and another in which the same learners were asked to discriminate L2 vowel contrasts. Participants were 16 Brazilian Portuguese speakers of American English, with a high degree of English proficiency. They were instructors of English for over 5 years. It was expected that their constant exposure to English would have already contributed to formed phonetic categories for L2 vowels.

In the production experiment, participants were asked to read sentences containing the target vowels in order to gather data for analysis. The sentences were digitized and the first two formants of each vowel were measured and compared to English speakers' data. In the perception experiment, a categorical discrimination test (CDT) was used to investigate the discrimination rate of English vowel pairs. Participants listened to sets of three words in which 1) each set contained an odd item or 2) all three items had the same target vowel, and were asked to indicate the odd item in the set or that all the items were the same.

The results of the first experiment showed that every English vowel produced was acoustically similar or acoustically identical to a Brazilian Portuguese vowel. While proficient in English, the participants tended to make use of their L1 vowel system to produce L2 vowels. While they were able to provide some slight contrast between similar sounds, these contrasts did not match those produced by native English speakers. Regarding the perceptual experiment, results showed that discrimination of the contrasts /∟/-/æ/, /⋃/-/u/, /▭/-/≙/ and /¯/-/≙/ was poor while discrimination of contrasts /⋃/-/¯/ and /⋂/-/e⋂/ was moderate and the /i/-/⋂/ contrast was the most accurate. Rauber et al. attributed the low discrimination rates to the fact that there are small F1-F2 differences between the vowels in these first pairs. The comparison between the perception and production tests gave evidence that perception precedes production of sounds and that inaccurate production was related to inaccurate perception.

In a similar study, Kluge et al. (2007) investigated the perception and production of English nasals /m/ and /n/ in syllable-final position by 20 Brazilian pre-intermediate learners of English. In the production experiment, participants were asked to read 144 sentences and were recorded. The data analysis was on the production of the nasal consonants /m/ and /n/ in the coda. Perception was assessed by a Categorical Discrimination Test (CDT) and a Native-like vs. Non-native-like Identification Test (IT). Both perception texts considered these previous vowels as a variable: /∩, æ, o∪, e∩, ¯/. The CDT consisted of 72 trials which contained sets of three words in which the set either had an odd item or all the items were the same (e.g., Tim-Tim-tin or Tim-Tim-Tim). Participants had to indicate the odd item in each trial (first, second, third) or indicate if they heard no difference. The IT consisted of 68 trials of pronunciations of the same monosyllabic word with either /m/ or /n/ in syllable-final position with either no contrast (e.g., /t∩m/-/t∩m/, two native-like or two non-native-like pronunciations) or two different pronunciations of the same word (e.g., /t∩m/-/t∩□/, one native-like and one non-native-like pronunciation). Participants had to indicate which pronunciation sounded more native-like or if they considered both pronunciations native-like or non-native-like.

With regard to production, participants' individual scores ranged from 44.44% to 72.92% accurate production of the target nasals. Results revealed that in most of the inaccurate productions, the participants nasalized the vowel while not producing the nasal consonant in order to produce the English coda nasals. Results from the perception experiments showed that fewer than half of the CDT and IT trials were correctly perceived by the participants. The previous vowels which most disfavored the accurate perception of the English coda nasals were /∩/ in the CDT and /e∩/ in the IT, while they were more accurately perceived with the previous vowel /¯/. Results also showed that the previous vowel /æ/ yielded the same difficulty in both tests. According to Kluge et al. (2007), these results indicated that high vowels seemed to disfavor accurate discrimination while low vowels seemed to favor accurate discrimination of the target nasals. Kluge et al. concluded from their study that the lack of fully realized coda nasals by the Brazilian learners was associated with their inaccurate perception in both perception tests. Their results indicated that there was some relationship between the identification and discrimination of the target coda nasals and their accurate production.

These studies have shown, based on Flege's Speech Learning Model (SLM) and Best's Perceptual Assimilation Model (PAM), that perceiving and producing different L2 sound contrasts pose different degrees of difficulty depending on the phonetic categories of the L1 and L2. Many phonetic and phonological mistakes can be attributed to first language influences. In addition, according to Aoyama et al., while perception and discrimination are affected by an individual's first language, it appears that the ability to discriminate non-native speech sounds could be lost with age. As a result, sound perception and the ability to perceive segmental features become contributing factors in communication problems. The results of these studies support the inclusion of the perception of segmentals in pronunciation curriculum. Furthermore, tests targeting student pronunciation needs should be designed with these features in mind.

When identifying a focus of pronunciation and perception instruction, what then should be taught in order to enhance an ESL student's communicative success? Munro and Derwing (2006) suggest focusing on the theoretical notion of *functional load (FL)* to prioritize issues in pronunciation teaching.

Functional Load

There is a need to establish some principles in looking at L2 speech perception in order to guide teachers in their curricular selections. One possible approach to determine what should be taught is based on the Contrastive Analysis Hypothesis. The Contrastive Analysis Hypotheses (CAH), formulated by Lado (1957), points out that a learner's first language influences aspects of second language acquisition. According to the hypothesis, first language features that differ from those of the target language will serve to hinder acquisition of related features of the target language due to "interference" from the first language. While such language transfer is certainly a part of the problem, Contrastive Analysis only aims to explain second language perception and production as a function of the similarity of the L1 and L2 phonemic inventories. A common challenge ESL instructors are faced with today is the prospect of having to teach to students of multiple language backgrounds. In such cases, instructors would have to know beforehand the similarities and differences between English (i.e., the L2) and every phonemic inventory of each learner's language (i.e., multiple L1s).

An alternative approach for pronunciation instructors looking to help their L2 learners to become effective communicators is to concentrate first on those aspects of L2 phonology that most affect intelligibility and comprehensibility (Munro & Derwing, 2006). Functional Load theory is something instructors can easily use in the classroom for identifying learners' intelligibility issues with segmental features of the target language (i.e., English). Applied linguists have extended the notion of functional load so as to rank segmental contrasts according to their importance in English pronunciation. This principle has become useful for choosing what segments should be included in speech perception analysis and training.

The notion of functional load has been around for some time. King (1967b) referred to functional load as “what is used in linguistics to describe the extent and degree of contrast between linguistic units, usually phonemes” (p. 831). While King gave a precise mathematical formulation to be used for computing functional loads (see Table 1), here is a brief discussion in general terms on what this formula measures. According to King (1967a) the formula for functional load is a product of two factors: 1) the global text frequencies of the two opposing phonemes; and 2) the degree to which the two phonemes contrast in all possible environments (where environment means one phoneme to the left and right). The functional load indices are all greater than or equal to zero. A functional load of zero means either that the two phonemes are in complementary distribution (for example with English [h, .·˙]) or that one of the phonemes did not occur in the input text.

Table 1 – King’s Measure for Functional Load

Source: King, 1987, p 4

$$L(x_i, x_j) = (N_i / N) \cdot (N_j / N) \cdot \sum_{k=1}^{m} (f_{ik} / N_i) \cdot (f_{jk} / N_j)$$

Note: $L(x_i, x_j)$ is the functional load of the opposition $x_i \neq x_j$; x_i is a phoneme; N equals the entire text; K equals the environment of a phoneme; N_i equals the total number of occurrences of phoneme $/x_i/$ in the entire text; F_{ik} equals the number of occurrences of the phoneme $/x_i/$ in the environment E_k.

According to King the majority of functional loads in the languages he first investigated (Modern Standard German, Old Icelandic, Old Saxon and Middle High German) ranged between 0.500 and 5.000, though smaller and larger functional loads were frequently obtained. In presenting data on functional load, King also included data on the relative frequency of each phoneme, as natural by-products of the computation of functional loads. Table 2 contains examples of King's listings of some functional load data for Modern Standard German.

Table 2 – Relative Frequencies and Functional Loads for

Modern Standard German Phonemes

Source: King, 1967a, p 10-11

Phoneme	Frequency	Load
/i/	4.346	2.390
/i⁄/	2.367	
/e/	3.700	8.829
/a/	4.066	
/a/	4.066	5.201
/o/	1.293	
/o/	1.293	0.152
/˙·./	0.233	
/u/	2.013	0.479
/u⁄/	1.007	
/p/	0.733	0.583
/b/	1.853	
/t/	8.153	10.984
/d/	4.593	
/m/	3.093	49.419
/n/	10.433	
/n/	10.433	3.836
/.·˙/	0.493	

It is important that in this model, individual phonemes (such as /p/ or /b/) do not have functional loads; it is the contrast between a pair of phonemes that determines the functional load (Brown, 1988).

Other applied linguists have ranked segmental contrasts according to their importance in English phonology. Brown dealt in particular with functional loads for pairs of Received Pronunciation (RP) phonemes often conflated by learners (/i∕, ⋂∕; ⋂⫫, e⫫; e, ∵; ▭∕ ▭⋂; u∕, ⋃; p, b; ƛ, d; n, .⋰; t∢, d↗/) in order to determine which ones a teacher should concentrate on remedying. Brown provided a cumulative frequency (see Table 3) for these pairs of phonemes (based on the individual frequencies given by Denes [1963]). The cumulative frequency of a pair is calculated by adding the individual frequencies for each phoneme. On the basis of these calculations, Brown proposed that a pair with a high cumulative frequency is of greater importance than one with a low cumulative frequency. Catford based his functional load calculations (see Table 4) on the "number of pairs of words in the lexicon that each vowel or consonant contrast serves to keep distinct," (Catford, 1987, p. 88). On the basis of these calculations both Brown and Catford propose that in a pronunciation course instruction should be concentrated on the phonemic oppositions with high functional load.

Table 3 – Individual and Cumulative Frequencies for

Received Pronunciation (RP) Phonemes

Source: Brown, 1988, p 598

Phoneme	Individual Frequency	Cumulative Frequency
/i⁄/	4.55	25.57
/∩⁄/	21.02	
/∩𝕃/	0.73	1.83
/e𝕃/	1.10	
/e/	7.16	11.05
/∵/	3.89	
/▭⁄/	3.05	3.28
/▭∩/	0.23	
/u⁄/	3.62	5.57
/∪/	1.95	
/p/	2.92	6.34
/b/	3.42	
/ƛ/	4.96	11.81
/d/	6.85	
/n/	11.66	13.72
/⋰/	2.06	
/t∢/	0.61	1.46
/d↗/	0.85	

Table 4 – Rankings of American English Phonemic Contrasts

based on Functional Load

Source: Catford, 1987, p 89-90

Contrast	Catford's Functional Load Ranking
/i/-/I/	95%
/æ/-/ɑ/	76%
/ɑ/-/ʌ/	65%
/I/-/ɛ/	54%
/eɪ/-/ɛ/	53%
/ɛ/-/æ/	51%
/p/-/b/	98%
/l/-/ɾ/	83%
/p/-/f/	77%
/t/-/d/	72%
/n/-/l/	61%
/t≮/ - /d↗/	19%

While King (1976a) and Brown (1988) used a 100-point scale and Catford (1987) used a percent-based ranking scale, their determinations were based on factors such as *structural position*, *complementary distribution* (or context) and *frequency of occurrence*. *Structural position* refers to whether two elements contrast at the beginning, middle or the end of a word (e.g., pill/bill; cap/cab). In determining functional load all the positions of a contrast must be considered. Second, *complementary distribution* or context is important because some minimal pairs may involve words from different parts of speech. For example, while there are several minimal pairs for initial /ƛ, d/, it is a phenomenon of English that words beginning with /ƛ/ are grammatical functions words (articles, demonstratives, connectives, such as *the*, *those*, *they*, *then* and *though*). They are unlikely to cause confusion in context with the corresponding /d/ words, which are virtually all lexical content words (nouns, verbs, adverbs, such as *doze*, *day*, *den* and *dough*). It is when they are in complementary distribution that confusion develops (e.g., coat/goat; ice/eyes). Finally, the importance of any particular phonemic contrast seems to be related to its *frequency of occurrence*, which is different from the number of words it distinguishes. For example, while we can find several minimal pairs showing the contrast /ʊ, u/, such as *would:wooed*, *could:cooed* and *should:shoed*, one member of each pair is of such infrequent occurrence that the minimal pair can hardly be said to have any importance. Therefore, the functional load of any given phonemic contrast depends on the existence of minimal pairs of words that are both frequent and appear in complementary distribution.

These considerations demonstrate the difficulty of arriving at an exact measure of functional load. Functional load has been variously defined (King, 1967b; Catford, 1987). Nevertheless, the concept of functional load has been very useful, and should find a place in our theory of language structure and teaching practice. Functional load has been proposed as a component of a full descriptive analysis of the sound system of a language (Brown 1988).[ii] For teaching purposes this can be included alongside descriptions of segmental and suprasegmental features. The concept of functional load is useful in the development of pronunciation assessment, curriculum and the teaching of pronunciation.

Although the notion has been discussed and used for several decades, beginning with King (1967a), until recently the usefulness of functional load rankings in predicting L2 learners' comprehension difficulties had not been tested empirically. Munro and Derwing (2006) did this, offering evidence that high functional load errors have greater impact on listeners' comprehension than low functional load errors. Munro and Derwing classified errors as having high functional load versus low functional load according to Brown (1991) and Catford (1987), where substitutions that Brown ranked from 6-10 and Catford ranked from 51% to 100% were considered as high functional load, and those below were considered as low functional load. For example, both Brown and Catford treated /l/-/n/ as a high functional load distinction[iii].

Munro and Derwing's recent study centered on the concept of functional load as a means for determining which consonant distinctions have the greatest impact on listeners' perception of accentedness and comprehensibility. Their study was designed to investigate theoretical predictions made by both Brown and Catford based on the functional load principle. The study was conducted using recorded samples of Cantonese speakers of English which were played back to native speakers of Canadian English and rated for degree of accentedness and then for comprehensibility. The stimuli consisted of 24 sentences containing errors with high functional load and low functional load contrasts as classified according to Brown and Catford. Patterns were chosen in order to compare the effects of high- and low- functional load errors on accentedness and comprehensibility. Their results indicate that high- functional load errors consistently lead to harsher accent ratings than low- functional load errors. A comparison of the effects of high- and low- functional load errors on comprehensibility revealed similar findings: high- functional load errors had significantly greater effect on listeners' ratings and caused greater processing difficulties than did low- functional load errors. According to Munro and Derwing, "functional load provides a framework for deciding which segmental errors deserve priority" (p. 530) in a pronunciation curriculum. While Munro and Derwing only considered the functional loads of consonant contrasts in their study, further work is needed on the effects of errors in vowel contrasts in varying functional loads or prosodic contrasts of different functional loads. They concluded by proposing work toward a comprehensive model of the factors that affect comprehensibility and intelligibility of second language speech, a model combining all aspects of speech, including consonants, vowels, prosodics, and voice quality.

The lack of ability of many L2 speakers to produce some sounds accurately is one of the causes of noticeable foreign accent in their L2. In addition, L2 speakers also have difficulties in accurately perceiving particular phonetic categories, a problem addressed in the literature as perceptual accent (Strange, 1995). L2 perception has been given considerable attention in recent years (Aoyama et al., 2004; Escudero, 2005; Bion, Escudero, Rauber & Baptista, 2006) and perception models have been introduced to describe relationships between L2 perception and production (Speech Learning Model [SLM] (Flege, 1995) and Perceptual Assimilation Model [PAM] (Best, 1995; Best, McRoberts, & Goodell, 2001)). We have seen how L2 learners' perception and production relate to comprehension and intelligibility of their speech. We have also seen through a review of recent work focusing on functional load the impact of high functional load errors on native speakers' comprehension of L2 learners' speech and how functional load can be used to prioritize issues in pronunciation teaching to address many concerns with accentedness, comprehensibility and intelligibility.

However, little has been done to measure the impact of functional load on learners' L2 speech perception. I propose below an instrument that can be used to study and identify these issues in L2 learners' speech perception as they relate to high and low functional load errors. The testing of perception of segmental features is proposed in order to offer focus and development for instruction in interlanguage phonology.

Instrument

Methods used in speech perception research can be divided into three groups: behavioral, computational, and, more recently, neurophysiological methods. Behavioral experiments are based on an active role of a participant, i.e., subjects are presented with stimuli and asked to make conscious decisions about them. Some forms of behavioral experiments include identification test, discrimination test or similarity rating. These types of experiments help to provide a basic description of how listeners perceive and categorize speech sounds. Most empirical evidence on segmental speech perception has been gathered using behavioral measures. For example, in order to measure native language influence on perception, Aoyama et al. (2004), Kluge et al. (2007), and Rauber et al. (2005) assessed perception through a Categorical Discrimination Test (CDT) where non-native speakers were asked to report whether a particular sound belonged to a specific category or sounded different from a designated category. Herein I propose an instrument with discrimination tasks which instructors can use to assess language learners' perception of segmental features of native English pronunciation that have different degrees of functional load. The presentation of results of the vowel and consonant contrasts would make extensive use of the construct of functional load because of its applicability in pronunciation skill instruction and assessment (Brown, 1991; Catford, 1987; Munro & Derwing, 2006).

Vowel Contrasts – Sections 1A and 1B

According to Catford (1987), Brown (1991) and more recently Munro and Derwing (2006), the teaching of pronunciation should be concentrated on phonemic oppositions with a high functional load. Therefore, the vowel section of this instrument is designed to test the perception of vowel contrasts with high functional loads. However, some pairs with lower functional load (such as /ʊ/-/u/ [FL7] and /ʌ/-/ʊ/ [FL9]) are included because of their spectral differences. The Perceptual Assimilation Model says that if two L2 sounds are perceived as only one L1 sound (i.e., single category assimilation), non-native discrimination will be poor. Most languages have between five to seven vowels; therefore, some non-native speakers of English have problems with the /ʊ/ phoneme. For example, some second language learners find it more difficult to perceive and produce short vowel sounds than long ones. If they see the words *pool/pull*, they tend to say something close to /pul/ in both cases.

Sections 1A and 1B of the instrument (see Appendix 1) consist of Categorical Discrimination Tests (CDT) based on Kluge et al. designed to investigate the discrimination rate of English vowel pairs. The first CDT is an oddity discrimination test in which every trial contains an odd item. Odd items vary in position: in some trials it is the first item, in others, the second, and in others the third position. This format is used to avoid bias in the answers due to the position of the odd item. The students are given an answer sheet with four alternatives for each set and asked to circle alternative (a), (b) or (c) to indicate the odd item, or alternative (d) if they hear no difference between the items. The students hear each item twice.

The second CDT is used because of its suitability as a test of category formation. Each vowel contrast of interest is tested by dyadic change trials or dyadic no-change trails. A change trial consists of a minimal pair (e.g., /bit/-/bIt/); while a no-change trial has no contrast (e.g., /næp/-/næp/). The students are given an answer sheet with two alternatives for each set and asked to circle alternative (same) if they consider both pronunciations the same or (different) if they consider the pronunciations to be different. The students hear each item twice.

The CDTs contain a total of 38 trials (19 oddity discrimination trials + 19 dyadic change/no-change trials). Students are presented with a total of 10 vowel contrasts. Each contrast appears four to five times between the two task types. Table 5 illustrates the phonemic contrasts along with their functional load and where they occur in the two tasks.

Table 5 – Vowel Contrasts

Source: Catford, 1987, p 89-90

Phonemic Contrast	Functional Load / Minimal Pair Example	Part 1A Item #	Part 1B Item #
(/i/-/I/)	95%	2, 7	20, 24, 28
	beat/bit		
(/æ/-/ɑ/)	76%	1, 6, 13	26, 30
	axe/ox		
(/ɑ/-/ʌ/)	65%	3, 8	21, 27
	collar/color		
(/I/-/ɛ/)	54%	17, 19	33, 38
	bitter/better		
(/eɪ/-/ɛ/)	53%	11, 14	22, 34
	hailed/held		
(/ɛ/-/æ/)	51%	5, 16	29, 31
	bet/bat		
(/ʌ/-/ɚ/)	40%	9, 15	25, 32
	buds/birds		
(/ɑ/-/ɑr/)	31.5%	12, 18	35, 36
	cot/cart		
(/ʌ/-/ʊ/)	9%	4	23
	putt/put		
(/ʊ/-/u/)	7%	10	37
	pull/pool		
		19	19

Consonant Contrasts – Sections 2A and 2B

The consonant section of the instrument (see Appendix 1) is designed primarily to test consonant contrasts (excluding consonant blends) with high functional loads. However, the consonant contrast (/v/-/b/ [FL29]), while it carries a lower functional load, is also included because it tends to be more difficult to perceive depending on the learners' language background. Sections 2A and 2B consist of Categorical Discrimination Tests (CDT) and follow the same format as Sections 1A and 1B with equal number of trials for each section. Table 6 provides a list of the consonant contrasts and their functional loads.

Table 6 – Consonant Contrasts

Functional Load Source: Catford, 1987, p 89-90

Phonemic Contrast	*Functional Load / Minimal Pair Example* *Syllable Initial*	*Syllable Final*	*Part 2A* *Type*	*Item #*	*Part 2B* *Type*	*Item #*
(/p/-/b/)	98% pill/bill	14% cap/cab	S-I , S-F	1, 12	S-I, S-F	20, 34
(/l/-/ɾ/)	83% lice/rice	--	S-I	9, 17, 19	S-I	21, 26, 33
(/p/-/f/)	77% pan/fan	17% cup/cuff	S-I, S-F	5, 8	S-F, S-I	28, 35
(/t/-/d/)	74% time/dime	72% cart/card	S-F, S-I	14, 18	S-I, S-F	25, 36
(/n/-/l/)	61% nap/lap	75% Ann/Al	S-I, S-F	3, 7	S-I, S-F	23, 32
(/s/-/ʃ/)	53% sip/ship	* muss/mush	S-I, S-F	10, 16	S-F, S-I, S-I	22, 29, 38
(/k/-/g/)	50% coat/goat	29% tack/tag	S-F, S-I, S-F	4, 6, 11	S-I, S-I, S-F	24, 31, 37
(/v/-/b/)	29% vote/boat	* robe/rove	S-I, S-I, S-F	2, 13, 15	S-F, S-I	27, 30
				19		19

Note: S-I = syllable initial position; S-F = syllable final position

* no Functional Load data was found for these syllable final contrasts

Discussion

The Perception of Segmental Features in Spoken English instrument, which prioritizes issues in English as a Second Language pronunciation teaching based on the principle of functional load, can fill an important need in the area of diagnosing speech perception problems. This instrument may be used by ESL instructors to aid in the design of specific instruction aimed at improving the discrimination of English phonemes. Studies have shown the positive effects of training on the discrimination of English phonemes (Cenoz & Lecumberri, 1999; Pennington, 1998). Furthermore, learners may use their scores on the instrument to help raise awareness of their own speech perception problems, thus enabling them to improve their listening comprehension and self-monitoring abilities. Thus, the Perception of Segmental Features in Spoken English instrument may be a valuable tool for many different language situations, and may help teachers and learners in their quest for more effective communication in English. This instrument could also be used as a possible research tool to help provide empirical evidence in the areas of speech perception and long term training, in the context of longitudinal studies.

The instrument described above may be helpful for training on phonetic discrimination, but it also presents some limitations. It focuses only on some segments (simple vowels and consonants) and needs to be complemented at other segmental (diphthongs and consonant blends) and suprasegmental levels (stress, rhythm, intonation). This latter area could focus on perception of such features as. Further focus could be placed on helping learners to recognize syllable constituents: onsets, nuclei, and codas, as well as sentence recognition. This could help the teacher to understand the learner's difficulties in discriminating English segmental and suprasegmental features and offer further focus and development for pronunciation instruction. It could also be complemented with a production assessment of the same segmental features. The relationship between the activities of speaking (the articulatory level) and of perceiving speech (perceptual level) has not been frequently addressed. Yet it is an important issue, because speakers speak with the intention of being understood. Looking at listeners' production along side perception will assist instructors in understanding the issues learners face in overcoming the task of becoming more intelligible speakers. In spite of these limitations, the instrument described above may be helpful as a beginning point for ESL teachers in assessing their learners' perception of English segments that carry a particularly high functional load, and so are very important for comprehension of meaning.

Phonetic development in a second language is without doubt a complex process involving cognitive, linguistic and interactive factors (Pennington, 1998). As part of phonetic competence, sound discrimination is a necessary condition for second language learning, and should be measured and targeted by ESL teachers as a part of their pedagogy.

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Appendix 1: Instrument and Answer Sheets

Perception of Segmentals in Spoken English Instrument

Vowel Contrasts – Sections 1A and 1B.

Which word is different?	Are these words the same or different?
1. cot, cat, cot	20. ship, ship
2. fist, feast, fist	21. color, color
3. fond, fund, fund	22. held, hailed
4. put, putt, put	23. books, books
5. man, men, man	24. beat, bit
6. rack, rack, rock	25. birds, buds
7. heat, heat, hit	26. axe, axe
8. cot, cut, cut	27. lock, luck
9. girl, gull, girl	28. slip, sleep
10. pool, pull, pool	29. bet, bet
11. mess, mace, mace	30. sack, sock
12. shark, shock, shock	31. pedal, paddle
13. clack, clack, clock	32. fun, fern
14. shed, shed, shade	33. pen, pen
15. cut, cut, curt	34. sail, sail
16. letter, ladder, letter	35. lark, lock
17. pick, peck, pick	36. cot, cot
18. guards, guards, gods	37. soot, soot
19. letter, letter, litter	38. bitter, better

Consonant Contrasts – Sections 2A and 2B.

Which word is different?	Are these words the same or different?
1. pill, pill, bill	20. peer, beer
2. bent, vent, bent	21. lake, lake
3. nap, lap, nap	22. ash, ash
4. muck, muck, mug	23. nick, lick
5. past, fast, past	24. crave, grave
6. coat, goat, goat	25. toe, toe
7. Al, Ann, Ann	26. lice, rice
8. leap, leaf, leaf	27. robe, rove
9. ramps, lamps, ramps	28. cup, cuff
10. ship, ship, sip	29. ship, ship
11. bug, buck, buck	30. vote, boat
12. robe, rope, rope	31. come, come
13. base, vase, base	32. bone, bone
14. card, cart, cart	33. rain, lane
15. curve, curve, curb	34. cap, cab
16. muss, mush, muss	35. fan, fan
17. lake, lake, rake	36. wet, wed
18. tear, tear, dear	37. tag, tag
19. row, low, low	38. sell, shell

Perception of Segmental Features in Spoken English Student Answer Sheet

Name: ______________________________

Country of Origin: ______________________

Course Level: ❑ Beginning ❑ Intermediate ❑ Advanced

Part 1A – Vowel Contrasts Circle your answer

Practice Part 1A

1. A) B) C) D) I hear no difference
2. A) B) C) D) I hear no difference

Which word is different?

1. A) B) C) D)
2. A) B) C) D)
3. A) B) C) D)
4. A) B) C) D)
5. A) B) C) D)
6. A) B) C) D)
7. A) B) C) D)
8. A) B) C) D)
9. A) B) C) D)
10. A) B) C) D)
11. A) B) C) D)
12. A) B) C) D)
13. A) B) C) D)
14. A) B) C) D)
15. A) B) C) D)
16. A) B) C) D)
17. A) B) C) D)
18. A) B) C) D)
19. A) B) C) D)

Part 1B – Vowel Contrasts

Circle your answer

Practice Part 1B

1.	SAME	DIFFERENT
2.	SAME	DIFFERENT

Do these words sound the same or different?

20.	SAME	DIFFERENT
21.	SAME	DIFFERENT
22.	SAME	DIFFERENT
23.	SAME	DIFFERENT
24.	SAME	DIFFERENT
25.	SAME	DIFFERENT
26.	SAME	DIFFERENT
27.	SAME	DIFFERENT
28.	SAME	DIFFERENT
29.	SAME	DIFFERENT
30.	SAME	DIFFERENT
31.	SAME	DIFFERENT
32.	SAME	DIFFERENT
33.	SAME	DIFFERENT
34.	SAME	DIFFERENT
35.	SAME	DIFFERENT
36.	SAME	DIFFERENT
37.	SAME	DIFFERENT
38.	SAME	DIFFERENT

Name: ______________________________

Country of Origin: ______________________

Course Level: ❑ Beginning ❑ Intermediate ❑ Advanced

Part 2A – Consonant Contrasts Circle your answer

Practice Part 2A

1.	A)	B)	C)	D) I hear no difference
2.	A)	B)	C)	D) I hear no difference

Which word is different?

1.	A)	B)	C)	D)
2.	A)	B)	C)	D)
3.	A)	B)	C)	D)
4.	A)	B)	C)	D)
5.	A)	B)	C)	D)
6.	A)	B)	C)	D)
7.	A)	B)	C)	D)
8.	A)	B)	C)	D)
9.	A)	B)	C)	D)
10.	A)	B)	C)	D)
11.	A)	B)	C)	D)
12.	A)	B)	C)	D)
13.	A)	B)	C)	D)
14.	A)	B)	C)	D)
15.	A)	B)	C)	D)
16.	A)	B)	C)	D)
17.	A)	B)	C)	D)
18.	A)	B)	C)	D)
19.	A)	B)	C)	D)

Part 2B – Consonant Contrasts ◯ Circle your answer

Practice Part 2B

1.	SAME	DIFFERENT
2.	SAME	DIFFERENT

Do these words sound the same or different?

20.	SAME	DIFFERENT
21.	SAME	DIFFERENT
22.	SAME	DIFFERENT
23.	SAME	DIFFERENT
24.	SAME	DIFFERENT
25.	SAME	DIFFERENT
26.	SAME	DIFFERENT
27.	SAME	DIFFERENT
28.	SAME	DIFFERENT
29.	SAME	DIFFERENT
30.	SAME	DIFFERENT
31.	SAME	DIFFERENT
32.	SAME	DIFFERENT
33.	SAME	DIFFERENT
34.	SAME	DIFFERENT
35.	SAME	DIFFERENT
36.	SAME	DIFFERENT
37.	SAME	DIFFERENT
38.	SAME	DIFFERENT

Notes

[i] In recent years, several new textbooks focusing on pronunciation and geared toward ESL teachers have been published (e.g., Celce-Murcia, Brinton & Goodwin, 2010; Hewings, 2004; Teschner & Whitley, 2004) and new textbooks and software programs have appeared (e.g., Cauldwell, 2002, Grant, 2010; Hancock, 2003; Kalkstein Fragiadakis, 2006; Westwood & Kaufman, 2008). In addition, there has been an explosion of websites dedicated to the uncertain task of accent reduction.

[ii] Functional load has also been used to investigate and explain historical sound changes (King, 1967a). In addition, a spelling reform system based on functional load (which conflates pairs of phonemes that distinguish only a few words) has been proposed (Wells, 1986). Wells argues that "when functional load is low, then a contrast can be ignored, whereas when functional load is rather high, then presumably it ought to be reflected in the spelling," (Wells, 1986, p. 8).

[iii] Munro and Derwing found no conflict in these authorities' sets of rankings.